DOCUMENT RESUME

ED 072 388 CG 007 826

AUTHOR Davis, J. Kent
TITLE Cognitive Style and Hypothesis Testing.
PUB DATE 73
NOTE 18p.; Paper presented at the American Educational Research Association, New Orleans, 1973

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Cognitive Ability; *Cognitive Development; *Cognitive Processes; College Students; *Hypothesis Testing; Learning Processes; *Perception; Perceptual Development; Research Projects

ABSTRACT

The primary purpose of this study was to determine empirically whether an individual's cognitive style differentially influences his hypothesizing behavior within a relatively simple information processing task. A characteristic of cognitive style explored is the manner in which an individual perceives and analyzes a stimulus configuration; specifically, performance on the Hidden Figure Test (HFT) was used as an operational method of identifying an individual's cognitive style. In the experiment the HFT was administered to 404 students in introductory educational psychology classes. Analytic and global subjects were distinguished in terms of a median split on the HFT scores and then administered learning set problems. In general, the conclusion to be drawn from this data is that analytic subjects are more proficient hypothesis testers than are global subjects. However, additional research is needed to determine if the higher percent of errors of global subjects is due to a memory loss, lack of attention, faulty use of feedback or some combination of these factors. (Author/SES)

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

ED 072388

CG 007 826

COGNITIVE STYLE AND HYPOTHESIS TESTING[1]

J. Kent Davis

Purdue University

The topic of information processing occupies a central position in many of the various approaches to learning, especially those concerned with cognitive behavior. Within this rather broad domain of cognitive behavior, however, relatively little attention has been devoted to individual difference variables in comparison to the emphasis given task variables. An individual difference variable which seems likely to influence cognitive behavior is that of cognitive style. The term cognitive style has been used to refer to habitual modes of information processing (Messick, 1971). Although a number of different dimensions have been suggested within the rather general area of cognitive style, there is one characteristic which appears to be common to a number of these dimensions. This characteristic is concerned primarily with the manner in which an individual perceives and analyzes a stimulus configuration. Within the context of the present experiment, performance on the Hidden Figures Test (HFT) was used as an operational method of identifying an individual's cognitive style.

---

[1]Paper presented at the annual meeting of the American Educational Research Association, New Orleans, 1973.

FILMED FROM BEST AVAILABLE COPY

The results of several studies designed to examine the extent to which an individual's cognitive style influences information processing tasks in general show that the learning performance of Ss with an analytic cognitive style is superior to that of Ss with a global cognitive style. Davis and Klausmeier (1970), for example, found that analytic Ss identified concepts at varying levels of complexity in fewer trials than did global Ss. Similarly, Ohnmacht (1966) found that analytic Ss were superior to global Ss in a reversal-nonreversal concept identification task. Davis (1972) also found that analytic Ss did better than global Ss on a conditional concept learning task. Post hoc analysis of S's protocols suggested that global Ss were testing hypotheses from a relatively large hypothesis pool, many of which were irrelevant to the learning task, while analytic Ss sampled hypotheses from a relatively small hypothesis pool, the majority of which were relevant to the learning task. While these studies have generally shown differences in performance as a function of cognitive style, little attention has been directed to the various processes required in these tasks. The primary purpose of the present study, therefore, was to empirically determine whether an individual's cognitive style differentially influenced his hypothesizing behavior within a relatively simple information processing task.

Method

Subjects. The Hidden Figures Test (HFT) was administered to 10 sections of introductory educational psychology classes and involved testing a total of 404 Ss. One hundred four of the Ss were males and 300 of the Ss were females. Separate distributions of HFT scores, corrected for guessing, were made for males and females with the males having a mean score of 22.22 and a standard deviation equal to 9.49, while the females had a mean of 22.61 with a standard deviation of 7.33. In addition to administrating the HFT, each class was given one of two different sequences of 24, four-trial learning set problems. Each of the 10 classes was randomly assigned to one of the two sequences. Thus five classes received one sequence and five classes received the other sequence. Since the HFT and the learning set problems were administered on separate occasions, several Ss had an incomplete set of data and therefore only the data for Ss with complete data were included in the analysis. A total of 346 Ss served as the sample upon which that data was collected. Analytic and global Ss were distinguished in terms of a median split on the HFT scores. For the males the median was 25.00 and for females the median was 23.00. A total of 128 Ss had complete data for sequence I and were broken down into the following categories: 55 analytic females and nine analytic males, 47 global females and 17 global females. Five Ss, three females and two males, scored at the median and were not included in the analysis. Two hundred

twenty-one Ss had complete data for sequence II and were distributed as follows: 89 analytic females, 20 analytic males, 79 global females and 30 global males. Three Ss were dropped from the analysis since they scored at the median, two were females and one was male.

Stimulus Materials. The stimulus materials consisted of 24 pairs of consonants, each varying on four stimulus dimensions; letter (2 consonants), color (purple, blue, green, yellow, brown, red, or white), size (large or small), and position (right or left). Within a given four-trial problem each level of each dimension occurred equally often with each level of every other dimension. Thus the criterion for internal orthogonality was met. Twenty-four such problems were constructed and photographed for use in a slide projector. Figure 1 provides a description of one of the 24 problems along with a description of the eight possible patterns of choices corresponding to each of the four major hypotheses.

Procedure. The procedure followed in this experiment was similar to that outlined by Levine (1963). Two groups of analytic and global Ss were constructed by randomly assigning five of the introductory educational psychology classes to sequence I and the other five classes to sequence II. Subjects in each sequence were given the same 24 problems, identical instructions, and a preliminary demonstration problem of 16 trials in which size was the relevant dimension. Each group

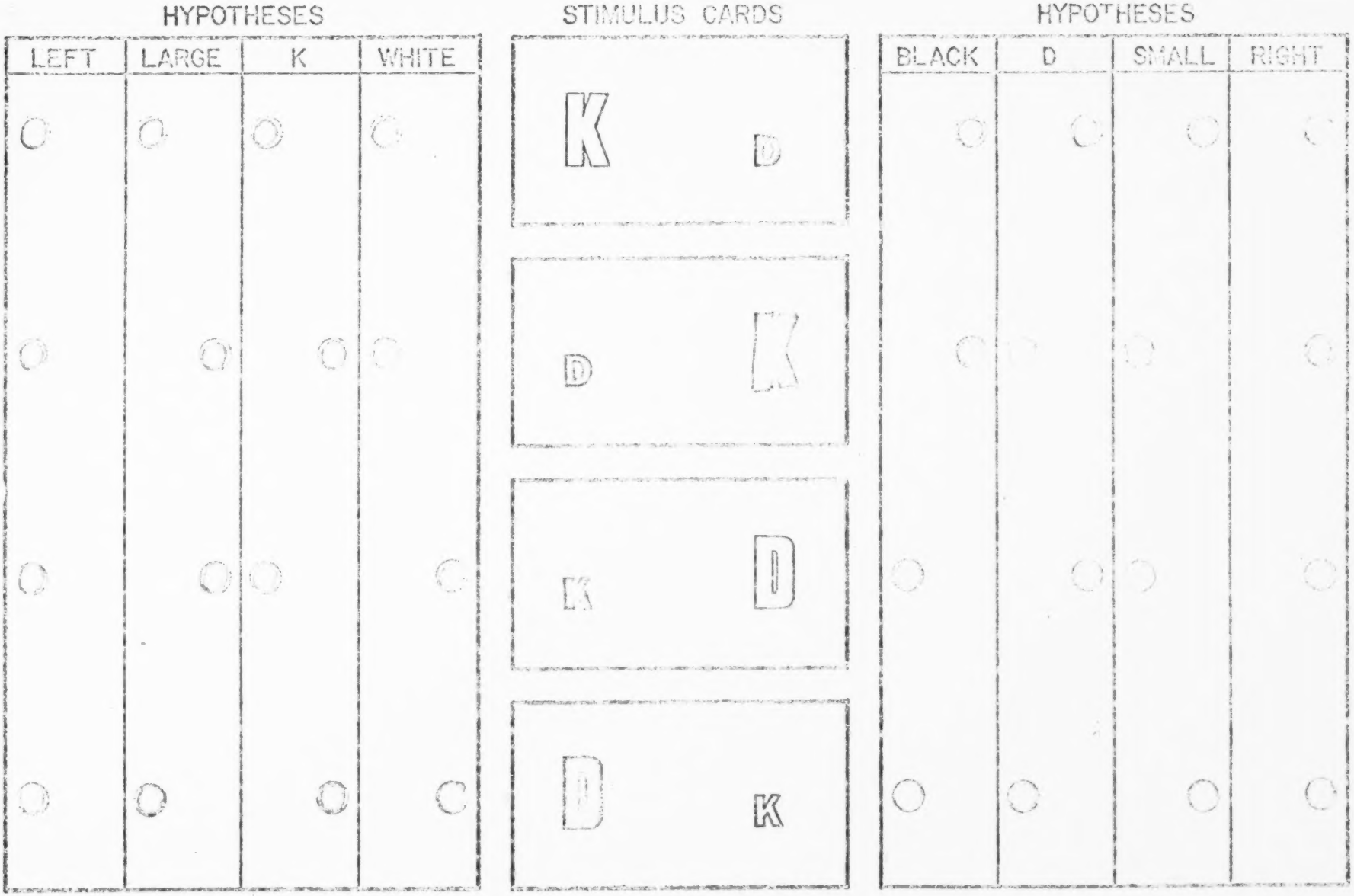

Fig. 1. Sample four-trial problem and response sequences.

received 18 outcome problems, in which the E provided feedback after Ss responded, and six nonoutcome problems, in which E did not provide any feedback. Subjects in sequence I received the nonoutcome problems on Problems 2, 6, 10, 14, 18 and 22; Ss in sequence II received the nonoutcome problems on Problems 4, 8, 12, 16, 20, and 24. The experimental paradigm is illustrated in Table 1. For each of the 18 outcome problems, the E provided feedback by pointing to the correct stimulus after each of the four trials. Subjects were given eight seconds to respond (using a specially prepared data sheet) and then the E pointed to the correct stimulus. Total exposure time for the outcome problems was 12 seconds per trial. Before the first nonoutcome problem, the E announced that the next problem would be a test of how much had been learned thus far. The class was told that during the next problem the E would not point to the correct stimulus, but that they should continue to try to get 100 percent correct. These test instructions were given before every nonoutcome problem. The exposure time for each trial of the nonoutcome problems was four seconds and between each trial there was a one second intertrial interval. A tape recorder was used to present the instructions and to control the temporal intervals for both outcome and nonoutcome problems. Color was the correct dimension for outcome Problems 1-12, and letter was the correct dimension for outcome Problems 13-24.

TABLE 1

EXPERIMENTAL PARADIGM

SEQUENCE	N	Relevant dimension											
		COLOR						LENGTH					
		2	4	6	8	10	12	14	16	18	20	22	24
I													
ANALYTIC	46	X		X		X		X		X		X	
GLOBAL	46	X		X		X		X		X		X	
II													
ANALYTIC	109		X		X		X		X		X		X
GLOBAL	109		X		X		X		X		X		X

X Problems on which the nonoutcome procedure was followed

Results. Sex was not treated as a variable in the analysis of this study for several reasons: first, the normal sex differences in HFT performance was not obtained; second, there were relatively fewer males than females in the available sample and; finally, preliminary analysis of the data indicated that there was no significant differences attributed to sex.

The dependent variable in this study was the percent of Ss manifesting a given response pattern which corresponded to one of five possible hypotheses on each of the nonoutcome problems. The specific hypothesis a S used was determined by classifying his sequence of responses over the four trials of a given nonoutcome problem. For each nonoutcome problem there are five possible hypotheses: one for color, one for size, one for letter, one for position and one for error hypotheses. Figure 1 illustrates the eight possible response sequences which conform to one of the four major hypotheses as specified in the instructions to the Ss. For example, a S was classified as using a position hypothesis if he placed all four of his responses in the left hand column of his answer sheet for a given nonoutcome problem. The S was classified as using a color, letter, or size hypothesis if his response pattern matched the respective response pattern for that hypothesis (See examples in Figure 1). In addition to these eight response sequences, there are eight unique response sequences which were classified as error hypotheses. Any response sequence involving a 3-1

pattern was classified as an error hypothesis.

The percent of analytic and global Ss manifesting each hypothesis on each nonoutcome problem is presented in Figure 2. In Figure 2 the solid line represents the performance of analytic Ss and the broken line represents the performance of global Ss. It is important to note that each data point in this graph represents the percent of Ss manifesting a given hypothesis on a nonoutcome problem and that the curves represent changes in the percent of Ss manifesting a given hypothesis recorded on problems when the E did not provide any feedback. Furthermore, the points represent four different groups: 46 analytic Ss and 46 global Ss who received the nonoutcome problem on Problems 2, 6, 10, 14, 18 and 22 (Sequence I), 109 analytic and 109 global Ss who received the nonoutcome problems on Problems 4, 8, 12, 16, 20 and 24 (Sequence II). Despite the difference in the number of Ss in Sequence I and II, and despite this relatively unorthodox method of reporting data, the curves are quite regular.

The increase in the percent of Ss responding to the color hypotheses over Problems 2-12 means that an increasing number of Ss are following a response pattern which corresponds to the color hypothesis on these nonoutcome problems. Likewise the decrease in the proportion of Ss responding to the color hypothesis over Problems 13-24 means that a decreasing number of Ss are following a response pattern which corresponds to the color hypothesis on these nonoutcome problems.

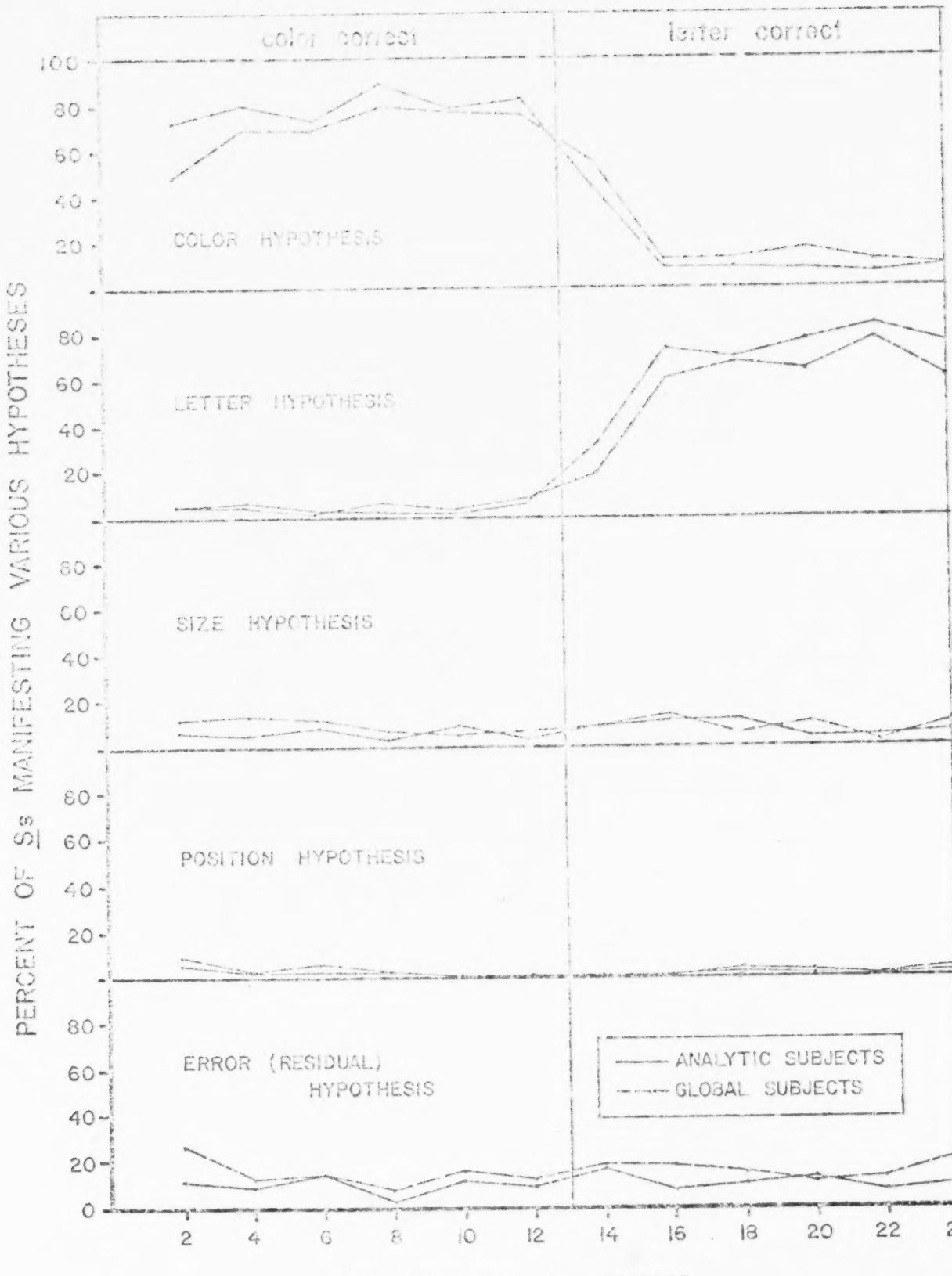

Fig. 2. Percent of Ss manifesting various hypotheses as a function of cognitive style.

Several features of this graph are noteworthy and will be presented in terms of the relevant dimensions to solution.

Color Learning Set. A higher percentage of analytic Ss responded to the correct dimension during the color learning set problems than did the global Ss. For Problem 2, 72 percent of the analytic Ss and 48 percent of the global S responded on the basis of color and this difference was significant at the .05 level, t (90) = 2.87. For Problem 4, 80 percent of the analytic Ss and 69 percent of the global Ss responded on the basis of color and this difference approached significance (t (216) = 1.92; $p < .10$). For Problem 6, 73 percent of the analytic Ss and 69 percent of the global Ss manifested a color hypothesis, but this difference was not reliable, $t < 1$. For Problem 8, 89 percent of the analytic Ss and 79 percent of the global Ss responded on the basis of the color hypothesis and this difference was significant, t (216) = 2.09; $p < .05$. For Problems 10 and 12, a greater percentage of analytic Ss responded on the basis of color than did global Ss (78% versus 77% for Problem 10 and 82% versus 75%, for Problem 12), but these differences were not significant.

When color was the correct basis of responding, there was little difference between analytic and global Ss in terms of the proportion of Ss manifesting either a letter or position hypothesis. As can be seen in Figure 2, both of these hypotheses occurred quite infrequently during the color learning set.

In general, global Ss manifested a slightly higher proportion of size hypotheses than analytic Ss and the combined proportion of Ss manifesting a size hypothesis was slightly higher than that obtained for either the letter or position hypothesis.

Global Ss consistently manifested a greater percent of error hypotheses (3-1 pattern) than did analytic Ss. The greatest difference between the two groups occurred on Problem 2, where analytic Ss had 12 percent error hypotheses and global Ss had 25 percent.

Letter Learning Set. At Problem 13 the feedback supplied by E switched from the color dimension to the letter dimension for the outcome problems. As can be seen in Figure 2, a large percent of both analytic and global Ss still maintained the color hypothesis for Problem 14. Fourty-four percent of the analytic and 55 percent of the global Ss manifested the color hypothesis. The percent of Ss following a color hypothesis, however, decreased quite rapidly after Problem 14 and stabilized around 10 percent for the remaining nonoutcome problem. Also, it should be noted that a higher percent of the global Ss consistently responded to the color dimension than did the analytic Ss over the remaining problems.

Analytic Ss showed a greater percentage of Ss manifesting a letter hypothesis than global Ss. Both groups of Ss, however showed a relatively typical acquisition function of the letter

hypothesis. Although the analytic Ss consistently demonstrated a greater percent of Ss manifesting the letter hypothesis, there were significant differences for only two of the problems. For Problem 14, 31 percent of the analytic Ss and 19 percent of the global Ss manifested a letter hypothesis, but this difference was not significant, $t < 1$. For Problem 16, 72 percent of the analytic Ss and 60 percent of the global Ss responded on the basis of the letter hypothesis and this difference approached significance, $t\ (216) = 1.90$, $p < .10$. For Problem 18, the percentage of Ss responding on the basis of the letter hypothesis was 69 percent for analytic Ss and 67 percent for global Ss ($t < 1$). For Problem 20, 77 percent of the analytic Ss and 63 percent of the global Ss responded to the letter dimension. This difference was significant at the .05 level, $t\ (216) = 2.30$. For Problem 22, there was no significant differences between analytic and global Ss ($t < 1$). For Problem 24, 75 percent of the analytic Ss and 61 percent of the global Ss responded to the letter dimension and this difference was significant at the .05 level, $t\ (216) = 2.24$. It should be noted that all of the significant differences occurred on the nonoutcome problems for Ss receiving sequence II.

For the letter learning set problems the percent of Ss manifesting size and position hypotheses was essentially the same as that for the color learning set problems: few Ss demonstrated a position hypothesis and there was little difference between analytic and global Ss in terms of the proportions of Ss responding to the size, dimension.

Data for the error hypothesis (3-1 patterns) was similar to that obtained for the color learning set problem. In general, global Ss had a higher proportion of error response sequences than analytic Ss. There was a slight reversal at Problem 20 where global Ss had 9 percent error hypotheses and analytic Ss had 11 percent. There was also a relatively greater increase in error hypotheses for global Ss for the last two nonoutcome problems.

Discussion. The results of the present experiment indicate that Levine's (1963) results have been replicated in several respects. First, both Levine's data and the data of the present study demonstrated that the position hypothesis rarely occurs. The most direct interpretation of this finding is that adult human Ss probably do not regard position as an important dimension in this type of learning situation. Second, both Levine's data and data of the present experiment show a slight increase in the strength of an apparently extinguished hypothesis (e.g. size hypotheses and error hypotheses) when the learning set changed (Problem 13). A minor exception, however, was noted in the present study. Levine reported that the percent of size, position and error hypotheses increased following the switch from a color learning set to a letter learning set. The present study did find a slight increase for both the size and error hypotheses, but did not find any increase in the case of position. Third, as Levine found, more

proficiency was obtained on the first learning set (color) than on the second learning set (letter). In the present study, 76 percent of all Ss responded correctly to the color learning set problems while only 64 percent responded correctly to the letter learning set problems. These figures show the same relationship as those reported by Levine, but differ in terms of absolute value in that Levine reported 84 percent and 60 percent, respectively. As suggested by Levine, this finding probably reflects that fatigue, boredom or other sequence effects depressed performance on the latter learning set. Overall then, the results of this study support the findings of Levine.

The primary objective of this study was to consider the individual difference variable of cognitive style as it relates to hypothesizing behavior In general the conclusion to be drawn from this data is that analytic Ss are more proficient hypothesis testers than are global Ss. This conclusion, however, must be considered tentatively since the number of Ss receiving sequence I and sequence II differed considerably which may have resulted in measurement which was not totally reliable. Nevertheless, several sources of data support the interpretation that analytic Ss are more efficient than global Ss. For both learning set problems, analytic Ss achieved greater proficiency than global Ss. For all nonoutcome problems involved in the color learning set, analytic Ss' response sequences conformed to

a color hypothesis 80 percent of the time, while global Ss responded on the basis of color hypothesis only 71 percent of the time. Similarily, for the letter learning set, analytic Ss achieved an overall percentage of correct responses 70 percent of the time compared to 59 percent for the global Ss.

Consideration of errors may provide some evidence concerning how analytic and global Ss differe in terms of the cognitive processes they employ in the hypothesis testing situation. Two different types of errors are possible when the learning set methodology is employed. The major type of error is reflected when a S follows any of the eight possible 3-1 patterns on the nonoutcome problems. This type of error, hereafter referred to as a type I error, means that a S switched from one stimulus dimension to another stimulus dimension in the absence of any feedback. This behavior may either reflect an overt error in responding (i.e., a careless error due to a loss of memory or lack of attention to the details of a specific stimulus pair), or a covert error (i.e., S providing himself with feedback or a delay in processing information previously presented by E). The methodology employed does not provide a means for identifying the specific reason for a S manifesting a type I error. The second type of error, hereafter referred to as a type II error, is reflected when a S follows a response sequence which corresponds to one of the three irrelevant stimulus dimensions. For example, when color is the relevant dimension a type II error would be made when a S responds on the basis of letter, size or position.

In the present experiment analytic and global Ss differed in terms of the frequency of type I and type II errors. For the color learning set problems, analytic Ss manifested a type I error 9 percent of the time and a type II error 11 percent of the time. Global Ss, for the color learning set problems, manifested a type I error 13 percent of the time and a type II error 16 percent of the time. For the letter learning set problems, analytic Ss had 10 percent type I errors and 20 percent type II errors. Global Ss, on the other hand, had 15 percent type I errors and 27 percent type II errors. Overall, global Ss had a higher percent of both type I and type II errors. Since the method employed in the present experiment does not provide a means for specifying the reason for these type of errors we can only speculate that they are the result of a combination of factors. Additional research is needed to determine if the higher percent of errors of global Ss is due to a memory loss, lack of attention, faulty utilization of feedback or some combination of these factors.

References

Davis, J. K. Cognitive style and conditional concept learning. A paper presented at the annual meeting of the American Education Research Association, Chicago, April, 1972.

Davis, J. K. & Klausmeier, H. J. Cognitive style and concept identification as a function of complexity and training procedures. Journal of Educational Psychology, 1970, 61, 423-430.

Levine, M. Mediating process in humans at the outset of discrimination learning. Psychological Review, 1963, 70, 254-276.

Ohnmacht, F. W. Effects of field independence and dogmatism on reversal and nonreversal shifts in concept formation. Perceptual and Motor Skills, 1966, 22, 491-497.